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Changing Perspectives in Australian Archaeology, Part VII

Aboriginal Use of Backed Artefacts at Lapstone Creek Rock-shelter, New South Wales: An Integrated Residue and Use-wear Analysis

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ABSTRACT. Early models of backed artefact use in Australia proposed that they were typically barbs or tips on spears or ceremonial/ritual objects. More recent models suggested their use as domestic tools, although often with the implication that backed artefacts had a single, dominant use. This paper presents the results of an integrated residue and use-wear analysis of a sample of backed artefacts from Lapstone Creek rock-shelter, an Aboriginal occupation site on the eastern escarpment of the Blue Mountains, New South Wales. The site, also known as Emu Cave, was excavated in 1936 by C.C. Towle, F.D. McCarthy and others, and the artefacts are currently housed in the Australian Museum, Sydney. Microscopic analysis of the backed artefacts revealed a range of craft and subsistence activities occurring at the site during the late Holocene. Evidence for the use of backed artefacts for bone-working and wood-working, as well as non-woody plant processing and possibly butchery was identified, with many artefacts also exhibiting evidence for hafting. Ochre, both red and yellow, was a recurrent residue, and animal hair was also observed. Backed artefacts were used as awls, knives, scrapers and incisors for the various tasks, indicating that they were multi-functional tools. This research makes a significant contribution to our knowledge of backed artefact use and provides insight into activities undertaken during a period of dramatic cultural and environmental change in the late Holocene.

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Backed artefacts were produced in southeastern Australia as early as 8500 cal. BP, but between 3500 cal. BP and 1400 cal. BP they were manufactured and discarded in large numbers in numerous sites (Hiscock, 2002: 167, 2008: 145–161, 239; Hiscock & Attenbrow, 1996, 1998, 2004, 2005). After this period, backed artefact production declined and they were not recorded in use at the time of British colonization. Since the "backed artefact proliferation event" (Hiscock, 2002) in southeastern Australia may have been precipitated by changing climatic conditions (Attenbrow, 2004; Attenbrow *et al*., 2009; Hiscock, 2008), knowledge of the role of backed artefacts during this period should contribute to this debate.

For over a century archaeologists have proffered a range of hypotheses about backed artefact use (summarized in Attenbrow, 2002: 101; Robertson, 2005: 7–10; see also Kamminga, 1982; Mulvaney & Kamminga, 1999: 235;

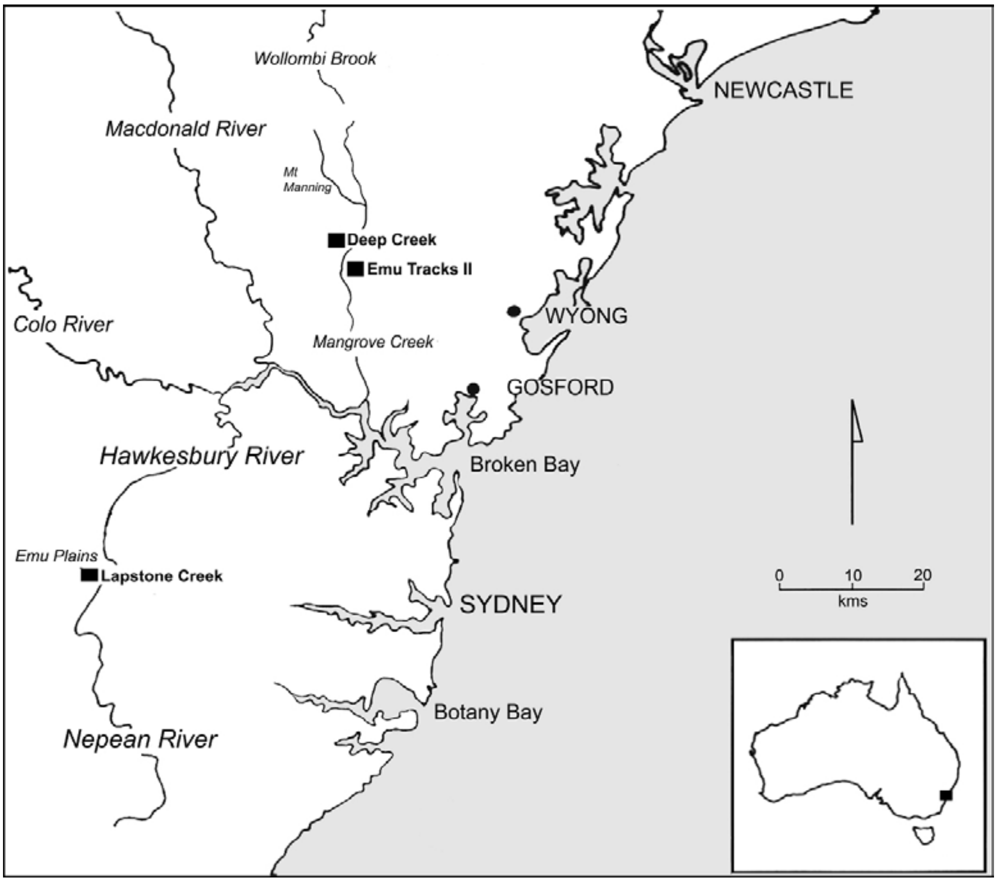


Figure 1. Location of Lapstone Creek rock-shelter and two other sites, Deep Creek and Emu Tracks 2, mentioned in the text below (from Robertson, 2005: fig. 4.1).

Robertson, 2009; Robertson & Attenbrow, 2008: 32; Robertson *et al*., 2009). Most early models proposed that they were typically barbs or tips on spears or ceremonial/ritual objects, while more recent models suggested their use as domestic tools, often implying a single dominant use. These early propositions were primarily based on morphology and ethnographic analogy and, because the artefacts were small, many scholars presumed they must have been hafted. Backed artefacts in the stone artefact assemblage from Lapstone Creek rock-shelter (or Emu Cave, as it was also known) were subjected to an integrated microscopic residue and use-wear analysis as part of a research project aimed at answering fundamental questions concerning the use of Australian backed artefacts. Specifically, the task/s they were associated with, how they were used and whether or not they were hafted were investigated.

The excavations at Lapstone Creek rock-shelter are significant for Holocene archaeology in Australia, although various aspects of the excavation in 1936 have proved controversial, particularly in McCarthy's (1948, 1978) reporting of events (Nelson, 2007). The stone artefact assemblage contained a considerable number of backed artefacts, including "points" and eloueras, and their distribution in different layers led to McCarthy's assertion that they represented two different culture periods, termed "Bondaian" and "Eloueran" (McCarthy, 1978). This paper details the results of the analysis of a sample of backed artefacts from Lapstone Creek rock-shelter, and discusses their implications for Aboriginal use of backed artefacts during the mid-to-late Holocene, the period of a marked proliferation in their manufacture and use.

The Lapstone Creek Site

Lapstone Creek rock-shelter faces north and is at the lower end of a gully, down which Lapstone Creek flows to the east across Emu Plains to the Nepean River (Fig. 1). It is situated about 10 m above the creek and is approximately 3 m deep and 10 m long, with a smoke-blackened ceiling and a platform of large sandstone blocks across the entrance (Fig. 2). Lapstone Creek rock-shelter was excavated in December 1935 and January 1936 by C.C. Towle, F.D. McCarthy and others (McCarthy, 1948, 1978). The results of the excavations are difficult to interpret as McCarthy joined the team after work had commenced and, due to a variety of circumstances, did not have access to the complete set of field notes written by Towle until some time after he had published his first paper on Lapstone Creek in 1948. The 1948 paper, published after Towle's death, was based on McCarthy's analysis of the Australian Museum collection and a report written by Towle. The additional information obtained from Towle's field notes prompted a later paper, which provided further data and revised some earlier interpretations (McCarthy, 1978). Nelson (2007: 40–41) noted several anomalies and errors regarding the fieldwork in both of McCarthy's publications, but these do not impinge on the landmark evidence for the two culture periods noted above. Two radiocarbon dates were obtained for the site: 2300±100 BP (ANU-011) and 3650±100 BP (ANU-010), the latter at a depth of about 91 cm (McCarthy, 1978: 55). The samples appear to have been collected from a hearth which had been used continuously and which backed onto part of the rock wall. Thus the earliest Bondi points in this site are at least 3650 years

Figure 2. Lapstone Creek rock-shelter 3/3/2002. Photo courtesy of V. Attenbrow, Australian Museum, Sydney.

old, since bedrock was reached at 99 cm and "[t]he *Bondi* points were met with in it at a depth of 90 cm and were then found down to the rock-floor" (McCarthy, 1948: 4). Most Bondi points were "met with" at a depth of from 71 to 76 cm (McCarthy, 1948: 11).

According to Towle (McCarthy, 1978), as well as a large number of other stone artefacts, the excavations yielded 84 elouera and 175 "chipped points and microliths." McCarthy revised the latter to 188 (Bondi) points and three (geometric) microliths. Preservation of macro-organic material at the site was apparently poor. Recorded faunal remains consisted of a few small pieces of animal bone, some of which were burnt fragments, a fragment of fresh-water mussel shell, and two snail shells all found in upper layers (McCarthy, 1948: 22). No shell or bone implements were found and the only mention of flora is "[a] nut from a bush tree …" (McCarthy, 1978: 51).

The artefacts

Two hundred and ninety-six artefacts from Lapstone Creek rock-shelter, variously labelled "points, eloueras, and fabricators," were obtained on loan from the Australian Museum. Thirty-six artefacts were identified as fabricators, not backed artefacts, and 79 "points" had previously been used as part of a thesis (Johnson, 1979), and, during the course of that study were glued to cardboard sheets, rendering them unsuitable for analysis. A further 27 artefacts were not well provenanced and were also eliminated from the study. A random sample of 50 artefacts, comprising 17 eloueras and 33 (Bondi) points, was selected for analysis from the remaining 154 artefacts using a computerized Random Number Generator (for examples, see Figs 3a, 3b).

Methods and materials

Integrated microscopic residue and use-wear analysis was first applied to Australian artefacts by Fullagar (1986), and has since been used in a number of significant archaeological studies both in Australia and internationally (e.g., Fullagar, 1994, 1998; Cooper & Nugent, 2009; Field *et al.*, 2009; Hardy & Svoboda, 2009; Haslam, 1999, 2006, 2009; Lombard, 2005, 2008; Robertson, 2002, 2005, 2006, 2008, 2009; Robertson *et al.*, 2009; Rots & Williamson, 2004; Wadley & Lombard, 2007). In this study, analysis relied on both low and high magnification optical microscopes for observation, some biochemical testing and access to a comprehensive pictorial database of plant, animal and mineral residues and types of use-wear. The author and colleagues at The University of Queensland compiled the comparative dataset through experimental replication of various activities and, in some cases, from published data. Activities such as butchery, hunting, bone-working, skin-working, wood-working, general plant processing and also ceremonial or decorative activities each produce a combination of residues and wear on a tool most likely to reflect its use for that purpose. The comparative reference database was used to construct tables of anticipated residues and use-wear associated with various hypothesized tasks and these tables were employed to make inferences about the use of backed artefacts at Lapstone Creek rock-shelter (Table 1, adapted from Robertson, 2005: tables 3.2 and 3.4).

Residue analysis. Residue analysis refers to the methodology associated with the identification and interpretation of archaeological residues. Not all residues on stone artefacts result from use. Non-use-related residues may result from the manufacturing process, for example, hafting and/or tool decoration, or from some other activity. Taphonomic factors in the post-depositional environment or post-excavation processes may also produce residues on artefacts, and the differentiation of cultural from non-cultural elements present on an artefact is an important aspect of residue analysis.

Diagnostic organic residues on stone artefacts are generally characterized as either plant or animal. Plant residues typically found on stone tools include amorphous cellulose, plant tissues and cellulose fibres, starch grains, plant exudates (resin, gum and sap), phytoliths, raphides and druses. Microscopic identification generally relies on specific differentiating characteristics, particularly the

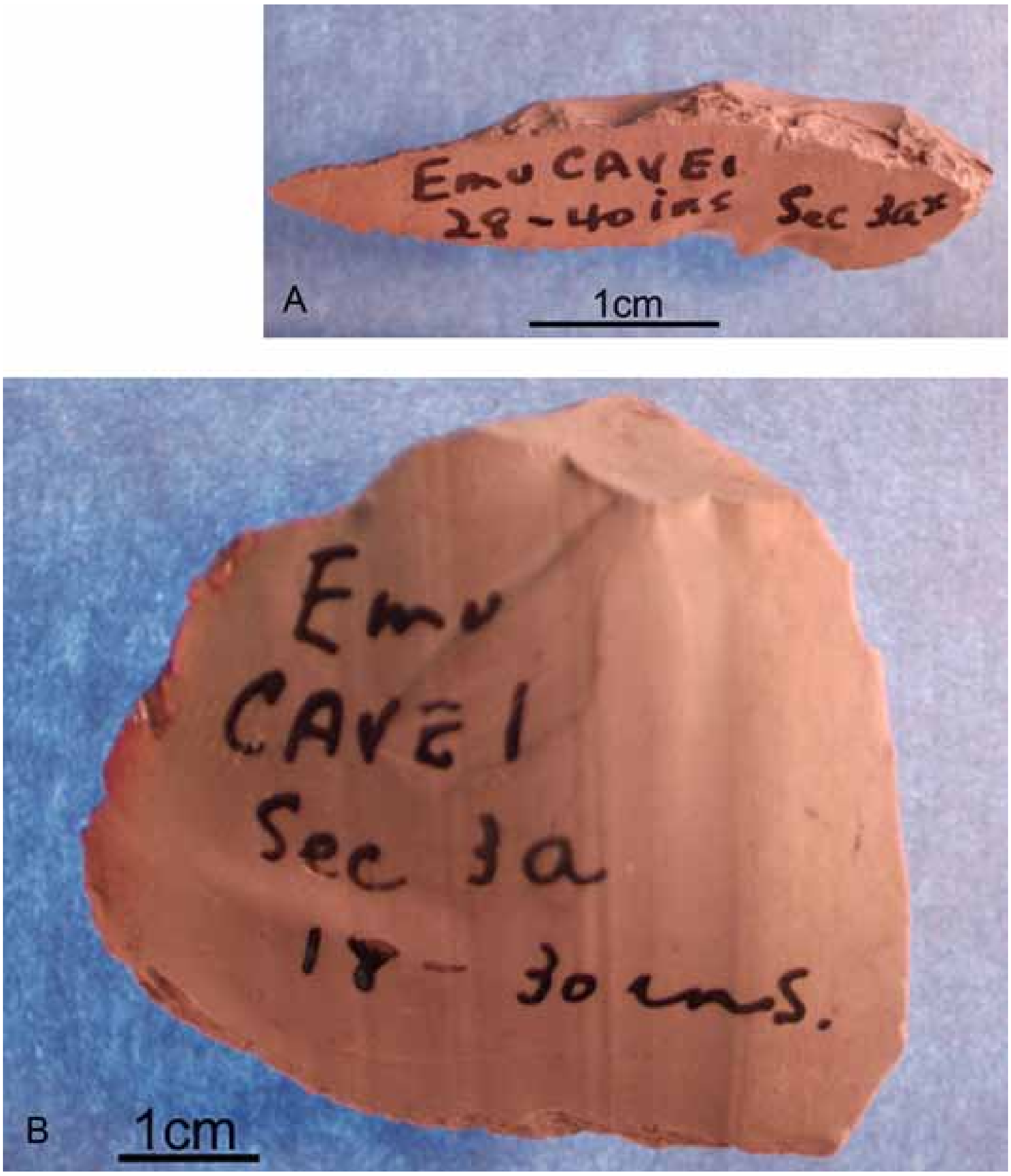


Figure 3. Examples of a "point" *(A)* and an elouera *(B)* from the Lapstone Creek assemblage.

morphology and behaviour of a residue under certain lighting conditions (for diagnostic criteria: Gunning & Steer, 1975: 117; Franceschi & Horner, 1980:381; Fullagar, 1986: 176; Horner & Wagner, 1995: 56; Raven *et al.*, 1999; Langenheim, 2003: 46; Haslam, 2004; Robertson, 2005: 54–70, 2006; Lombard, 2005, 2008: 37–38; Crowther, 2008, 2009; Cooper & Nugent, 2009; Hardy & Svoboda, 2009). Animal residues identified on stone artefacts include animal tissue and fibres (such as collagen and muscle), blood (including proteinaceous films and red blood cells), lipids, bone, hair and feather (for diagnostic criteria: see Loy, 1983, 1985, 1990, 1993, 1994; Loy & Wood, 1989; Fullagar, 1986; Loy & Hardy, 1992; David, 1993; Sobolik, 1996; Loy & Dixon, 1998; Wallis & O'Connor, 1998; Williamson, 2000; Balme *et al.*, 2001; Tomlinson, 2001; Akerman *et al.*, 2002; Francis, 2002; Robertson, 2002, 2005: 70–80, 2006; Fullagar & Jones, 2004; Wadley *et al.*, 2004; Lombard, 2005, 2008: 38–39; Lombard & Wadley, 2007; Robertson & Attenbrow, 2008; Cooper & Nugent 2009; Hardy & Svoboda, 2009). Inorganic residues such as ochre, vivianite, aragonite and other minerals such as mica may also relate to stone tool use and are generally able to be identified microscopically (Francis, 2002; Wadley *et al.*, 2004: 662; Robertson, 2005: 80–85, 2006; Gowan & Prangnell, 2006; Lombard & Wadley, 2007).

Blood residues are notoriously difficult to differentiate microscopically and the Hemastix™ Test is a colourimetric biochemical test used to detect the presence of blood. The chemical reagents present in the test pad are highly sensitive to the presence of haemoglobin in aqueous solution and also register the presence of myoglobin, the latter a related protein found in muscle tissue and likely to be present on artefacts used for processing animal components. The test has clinical and forensic applications, but was first applied experimentally to archaeological samples in 1983 (Loy, 1983) and found to be a useful adjunct to microscopic and other methods of identifying blood on stone tools. However, other compounds are potentially capable of producing a positive reaction, including chlorophyll, manganese dioxide (MnO2), copper ions and bacterial and vegetable peroxidases (Custer *et al.*, 1988; Loy, 1993a; Loy & Dixon, 1998). Since some of these compounds, particularly chlorophyll and manganese oxides, are likely to be present in archaeological soils, a positive Hemastix™ Test result requires further testing to eliminate them as the source. The introduction of the chelating agent sodium-EDTA (ethylenediaminetetraaceticacid—sodium salt) removes the ions responsible for the "false positive" reaction (Loy, 1993b: 49; Fullagar *et al.*, 1996; Loy & Dixon, 1998). Thus a positive

Table 1. Residue and use-wear criteria for hypothesised task associations and functions (adapted from Robertson, 2005: tables 3.2 and 3.4).

Task association		Description of functions	Residues	Use-Wear
Primary animal processing	**Butchery**	Cutting skin and disarticulating bone, removing meat from bone.	Blood*, red blood cells*, proteinaceous film*, fibrous collagen*, muscle tissue, other connective tissue (collagen), fat, vivianite, hair, feather.[i,j,n]	Small bending and step flake scars, slight edge rounding.[k] Intersecting striae and striae parallel to the cutting edge.[l]
	Hunting	Impact/spearing, stabbing—mammal, reptile, bird.	Blood*, proteinaceous film*, tissue fragments*, collagen, hair, scales, feather, hafting resin. [m,n]	Damaged tip—possible high energy impact shattered, striations parallel or sub-parallel to the long axis, major damage to retouched edges/large microflake scars.[d,e] Finely striated polish.[l]
Bone-working	**Primary stage**	Scraping and cutting to remove flesh, sinew and periosteum.	Blood*, bone collagen* (sheet—periosteum, fibrils), bone fragments, connective tissue (collagen), fat and oil droplets, vivianite. [i,n]	Edge rounding and fracturing, striations at 45–90° to the edge, possible retouch.[k]
	Secondary stage	Cleaning of periosteum by scraping or cutting, smoothing and shaping/ modifying bone.	Sheet collagen* (periosteum), collagen fibrils*, bone fragments, granular bone collagen, proteinaceous film*, vivianite. [i,n]	Edge rounding and fracturing, striations perpendicular and/or parallel to the edge.[k]
	Tertiary stage	Working dry bone, engraving, smoothing, polishing, drilling, possibly sawing, adding fine detail, possibly decorating with ochre.	Granular bone collagen*, sheet collagen, bone fragments, ochre*, vivianite.[i,n]	Sawing: continuous distribution of bending and step flake scars[k,o], feather fractures[g], rounding/ smoothing[g], protein film or "polish" on ventral and dorsal aspects, striations parallel to the worked edge[k], but rare[i]; engraving: edge rounding, "polish", small step and bending scars[k]; drilling: rounding of apex and associated lateral margins, bending and occasional step fractures on lateral margins, frequent tip snapping but continued use[k], and polish.[i]

Task association		Description of functions	Residues	Use-Wear
Wood-working	**Wood-working**	Scraping, chopping, cutting, incising, adzing.	Woody plant tissue*, cellulose*, plant cells visible in tissue, cellulose fibres*, resin, plant sap or exudate*, bordered pits, cells with helical wall-thickening, charcoal, charred sap/resin.[b,f,n]	Scraping: edges, both acute and obtuse, exhibit moderate rounding with an almost continuous distribution of bending, and occasional feather and step flake scars, striations are generally broad and shallow if present[i]; polish[h]; incising/engraving: some edge rounding on the tip and lateral margins at the tip, with small step fractures[k], striations parallel to the working edge.[f]
Plant processing	**General plant working**	Cutting, shredding, removing bark (scraping).	Plant tissue*, amorphous cellulose fragments*, fibres, resins, sap or exudate*, small starch grains*, chlorophyll, phytoliths.[c]	Edge-scarring rare and small, usually only bending flake scars, slight to moderate rounding[g] and few or no striations.[i]
	Starchy plants and seeds	Scraping, chopping, cutting.	Starch grains*, cooked starch, plant tissue*, raphides, amorphous cellulose, plant fibres*, phytoliths.[j,n]	Edge-scarring rare and small, usually only bending flake scars, slight to moderate rounding and few or no striations.[h]
Cere-monial and Decoration	**Ritual scarification**	"Crimping" or cutting to form cicatrices on the body.	Blood/human*, connective tissue, lipids/fats, vivianite.	None.
	Misc.	Decorating *churinga* or other object or body.	Ochre, feathers, blood, muscovite mica or none.[a]	Unknown, possibly none.

Key

- * essential residues
- [a] Akerman et al., 2002
- [b] Anderson, 1980
- [c] Briuer, 1992
- [d] David, 1993:77–79
- [e] Dockall, 1997
- [f] Hardy & Garufi, 1998
- [g] Hayden, 1979
- [h] Hurcombe, 1992:148
- [i] Fullagar, 1986:172–191
- [j] Fullagar, 1992
- [k] Kamminga, 1982
- [l] Kay, 1996
- [m] Kooyman et al., 1992
- [n] Loy, 1994a
- [o] Tringham et al., 1974:189–191

reaction after the addition of a 0.5 M (molar) solution of sodium-EDTA to the sample is accepted as being indicative of the presence of haemoglobin/myoglobin on the tool, provided the test is not applied in isolation and is confirmed by other evidence, either microscopic or biochemical (for specific details of the Hemastix™ Test on Lapstone Creek rock-shelter artefacts, see Robertson, 2005: 71–72).

Use-wear analysis. Use-wear analysis refers to a range of techniques designed to obtain functional information from stone tools in addition to that provided by conventional morphological and technological approaches. It is a method of describing wear features attributable to tool-use and is also a means of interpreting function. In this study edge rounding, edge fracturing, striations, lineation and abrasive smoothing and polish were the major forms of use-wear recorded (Robertson, 2005 for definitions of terms, with reference to Kamminga, 1982; Keeley, 1982; Fullagar, 1986; Hurcombe, 1992). Under ideal conditions, use-wear analysis requires artefacts to be thoroughly cleaned, often with harsh chemicals, prior to microscopic examination. However, in an integrated study involving both use-wear and residue analysis, cleaning of the artefacts was not considered viable.

The mode of action or function of a tool is influenced by hafting and the presence of a haft may be inferred from traces of wear, although, according to Rots (2003: 812), the "use of resin often hinders trace production." Lombard (2005) used a multi-analytical approach that included both use-wear and the presence of resin to infer hafting on artefacts from Sibudu Cave in South Africa. In relation to interpretations of Australian artefact use, the presence of resin traces is the most distinctive hafting evidence recorded in most research. In this study, the presence and distribution of resin is considered the primary evidence of hafting, with wear features providing supplementary data.

A Wild stereo-binocular microscope with a magnification range from 6× to 30×, employing a Microlight 150 fibre-optic light with adjustable arms as a light source, was used for an initial examination of the artefacts to detect and record use-wear features and the distribution of visible residues, including resin. An Olympus BX60 metallographic microscope, with a series of objective lenses providing magnifications of 50×, 100×, 200×, 500× and 1000× diameters, was used for identification of organic and inorganic residues and use-wear attributes such as polish and fine striations not readily detectable at low magnification. Both microscopes were mounted with an Olympus DP10 digital camera. All images were taken by the author unless otherwise acknowledged in the captions.

There are specific difficulties associated with the analysis of museum specimens, including recognition of the numerous post-excavation factors, which may influence the results. Sieving and cleaning of artefacts is known to cause significant modifications to an artefact surface, particularly abrasion and striations, and also of course the removal or addition of residues (Hurcombe, 1992: 77; Kooyman, 2000: 154). Wear due to transport of artefacts by people, including researchers/analysts, or "bag-wear," is also of particular concern to use-wear analysts. Wear features considered in this study include abrasions, edge rounding, edge fractures and polish, and although these modifications are unlikely to be localized to a particular edge there is still a potential risk of confusion with use-wear. A specific contamination issue on the Lapstone Creek rock-shelter artefacts was the presence of a thick black ink label on one surface, which occasionally obscured the residues, particularly when the label overlapped an edge on some of the smaller artefacts (e.g., Figs 3a, 3b). All these issues were taken into account during the study.

There are also some methodological issues regarding confirmatory investigations such as biochemical testing and slide preparation that are particularly relevant to the Lapstone Creek assemblage. Some artefacts were considered too small and/or there was insufficient microscopic evidence of blood or animal residues to justify sample removal for the Hemastix™ Test and microscope slide examination.

Results

Table 2 summarizes the results and lists inferred task association/s and function/s (where allocated) of each of the 50 artefacts. Artefacts with similar inferred task associations and functions are discussed below under subheadings of wood-working, bone-working and other plant processing which were the principal assigned uses. Starchy plant processing was also identified as a task. More than half the artefacts exhibited evidence for hafting and this is discussed in conjunction with resins. Also included are sections on specific residues such as blood, ochre and hair, the presence of which requires further clarification. Of the 50 artefacts analysed, seven artefacts were unable to be assigned a specific task although six of these exhibited some evidence of use and the seventh was allocated a possible ceremonial or ritual role on the basis of residues. Figure 4 provides a broad overview of the results of the analysis. Although inferred task associations for each artefact are categorized separately, a number of artefacts were employed for more than one task and the major combinations of bone- and wood-working and bone-working and general plant processing are included in the chart to illustrate their use as multipurpose tools.

Bone-working. The inferred task association for 34 artefacts was bone-working (Table 2). For some of these it was possible to nominate either tertiary (n = 18) or secondary (n = 7) stage bone-working, based on the presence of residues and use-wear as listed in Table 1 (Figs 5 and 6). Five artefacts (LC#2, LC#23, LC#27, LC#35, LC#37) produced positive results (trace only) on testing with Hemastix™, but none had visible blood residues on microscopic examination. Positive reactions were probably due to the presence of myoglobin associated with working bone. On the other hand, microscopic analysis of LC#32 and LC#45 detected putative blood residues containing a few non-nucleated red blood cells (5μm) although neither produced positive reactions after the addition of NaEDTA during subsequent Hemastix™ tests. The lack of a positive reaction may have been due to a number of factors, including the possibility that the residue detected was not blood or the quantities of haemoglobin in the sample were too small for detection.

Eleven artefacts could not be assigned to a specific stage of bone-working because of either the small quantity of bone residues, the lack of use-wear features, or the location of bone residues without associated use-wear. For the latter and for several other artefacts in the assemblage (n = 11), the concept of a bone haft is proposed, although there are other possible explanations for the scattered bone residues, which will be discussed below.

A number of artefacts were multipurpose, occasionally with the same edges being used for all tasks, but often with different edges having different task associations. Twenty-five artefacts were used for both bone- and wood-working with one of these (LC#18) also used for processing starchy plants. A further six artefacts (LC#1, LC#2, LC#6, LC#14, LC#27, LC#32) were used for processing soft, fleshy or woody stems.

Table 2. Task association/s and hafting assessment for Lapstone Creek backed artefacts.

LC#	Artefact type	Animal task association	Animal function	Plant task association	Plant function	Other task association	Hafting assessment
1	Elouera	tertiary bone-working	scraping	general plant processing/woody &/or fleshy stems	scraping & cutting		insufficient evidence
2	Elouera	secondary bone-working	scraping	general plant processing/woody stems	scraping & cutting		insufficient evidence
3	Elouera	secondary bone-working	scraping	wood-working/ charred resinous	scraping & cutting		probably hafted
4	Elouera	tertiary bone-working	scraping & smoothing	wood-working/ hardwood	scraping & smoothing or burnishing		insufficient evidence
5	Elouera	secondary & tertiary bone-working	scraping	wood-working/ resinous	scraping & smoothing or burnishing		insufficient evidence
6	Elouera	tertiary bone-working	scraping	general plant processing	possible scraping		insufficient evidence
7	Elouera	secondary/ tertiary bone-working	scraping	wood-working/ resinous hardwood	scraping		insufficient evidence
8	Elouera	bone-working/ possible tertiary	scraping	wood-working/ hard or medium density wood	scraping		insufficient evidence
9	Elouera	tertiary bone-working	scraping	wood-working/ hard & charred	scraping—heavy use		insufficient evidence
10	Elouera	tertiary bone-working	scraping	wood-working/ hardwood	scraping &/or adzing		hafted
11	Elouera			wood-working/ charred; general plant & starchy plant processing	scraping &/or adzing		insufficient evidence
12	Elouera	bone-working / possible secondary	scraping	wood-working/ hardwood & charred	scraping &/or adzing		insufficient evidence
13	Elouera	tertiary bone-working	scraping	wood-working/ resinous hardwood/ charred	scraping &/or adzing—both edges used		insufficient evidence
14	Elouera	tertiary bone-working	scraping	plant processing/soft fleshy or woody stems	cutting & scraping		insufficient evidence
15	Elouera	tertiary bone-working	scraping	wood-working/ medium density wood / charred	scraping &/or adzing		probably hafted
16	Elouera	tertiary bone-working	scraping	wood-working/medium density	scraping &/or adzing		insufficient evidence
17	Bondi point			uncertain—probable wood-working	uncertain/ possible incising		insufficient evidence

LC#	Artefact type	Animal task association	Animal function	Plant task association	Plant function	Other task association	Hafting assessment
18	Elouera	bone-working/ possible tertiary	scraping	wood-working & starchy plant-processing	scraping & cutting		probably hafted
19	Bondi point			wood-working	possible incising		probably hafted
20	Bondi point			wood-working/ medium density	incising & scraping		probably hafted
21	Bondi point			uncertain- possible wood-working	scraping & incising		hafted
22	Bondi point			uncertain—probable plant or wood-working	possible incising & scraping		hafted
23	Bondi point	bone-working/ slight use	unknown—tip snapped	wood-working/ possible slight use	unknown—tip snapped		insufficient evidence
24	Bondi point			uncertain- possible plant processing, fleshy	scraping & incising		insufficient evidence
25	Bondi point					uncertain – ceremonial	insufficient evidence
26	Bondi point			general plant processing, resinous	tip snapped—possible cutting		hafted
27	Bondi point	tertiary bone-working	scraping & incising	general plant processing	incising & scraping		hafted
28	Bondi point			wood-working	incising		insufficient evidence
29	Bondi point			uncertain—possible plant processing	possible cutting & incising		hafted
30	Bondi point			uncertain—plant processing, slight use	possible cutting		probably hafted
31	Bondi point			wood-working, medium density & resinous	scraping & cutting		insufficient evidence
32	Bondi point	secondary bone-working &/or bone haft	uncertain—possible scraping	general plant processing	cutting & possible piercing or incising		probably hafted
33	Bondi point			wood-working/ charred	cutting & incising		insufficient evidence
34	Bondi point			wood-working	scraping & burnishing		insufficient evidence
35	Bondi point	secondary bone-working	scraping	wood-working/ medium density & resinous	incising or piercing		insufficient evidence
36	Bondi point	tertiary bone-working or bone haft	possible scraping	wood-working/ medium density	incising &/or piercing		hafted
37	Bondi point	tertiary bone-working or bone haft	scraping &/or bone haft	wood-working/ hardwood	incising or drilling		probably hafted
38	Bondi point	tertiary bone-working	incising &/or drilling				probably hafted
39	Bondi point	possible tertiary bone-working	incising &/or drilling	wood-working/ medium density	incising or drilling		probably hafted

LC#	Artefact type	Animal task association	Animal function	Plant task association	Plant function	Other task association	Hafting assessment
40	Bondi point	bone-working or bone haft	uncertain	wood-working/ resinous	incising		probably hafted
41	Bondi point	tertiary bone-working	incising &/or drilling	wood-working/ medium density-charred	incising or drilling		hafted
42	Bondi point	bone-working or bone haft	scraping	wood-working/ medium density-charred	tip snapped		hafted
43	Bondi point	bone-working or bone haft	incising	wood-working—slight use	uncertain—possible incising or drilling		hafted
44	Bondi point			wood-working/ possible charred/ resinous	scraping & cutting & incising		probably hafted
45	Bondi point	bone-working & possible bone haft	incising	wood-working/ hardwood	incising		probably hafted
46	Bondi point	bone-working & bone haft	cutting & scraping & incising				probably hafted
47	Bondi point	secondary bone-working & possible bone haft	incising &/or drilling				hafted
48	Bondi point	tertiary bone-working & bone haft	incising &/or chiselling & scraping	wood-working	incising & chiselling & scraping		hafted
49	Bondi point	tertiary bone-working & possible bone haft	incising	wood-working/ green resinous	scraping & cutting		hafted
50	Bondi point	possible bone-working & bone haft	uncertain	wood-working/ hardwood	incising		probably hafted

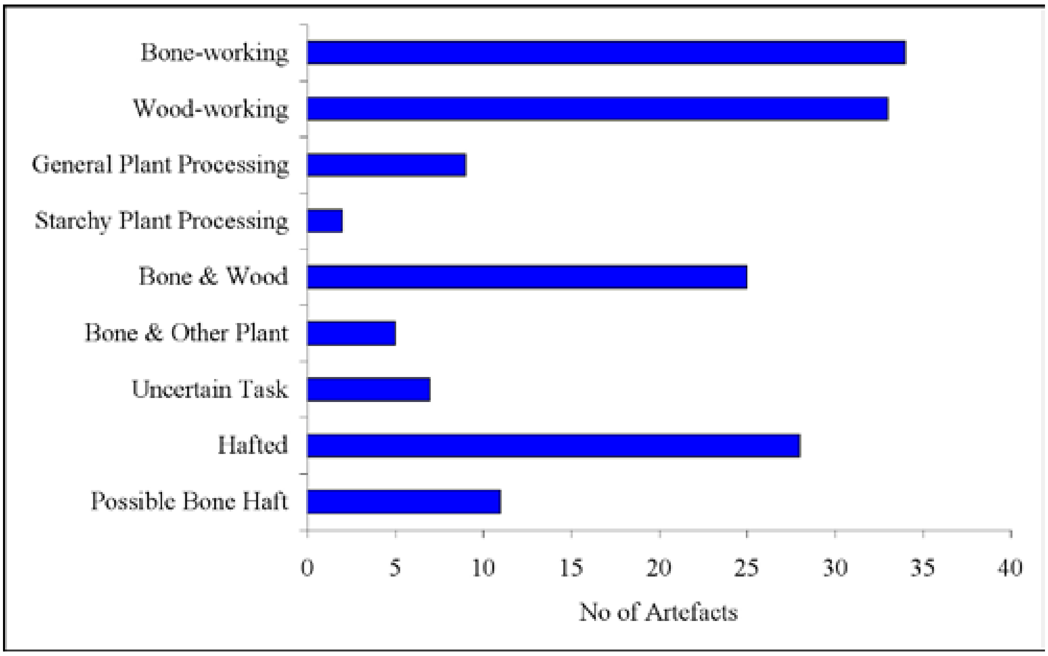


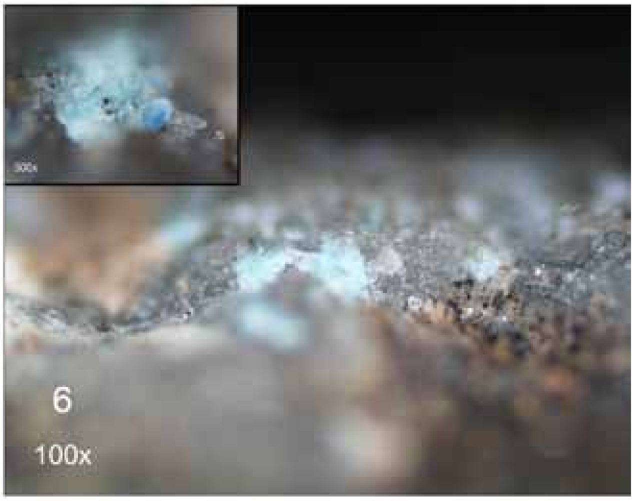
Figure 4. Inferred task association/s and hafting assessment for artefacts from Lapstone Creek.

In most cases, at least for the eloueras (n = 16), the artefacts were used for scraping (wood and bone) and/or adzing or cutting (wood only) (Fig. 7). For the multipurpose Bondi points (n = 15), the principal inferred function was incising, except for LC#23 which had a snapped tip and for which a function was not able to be determined, and LC#35, LC#36 and LC#37 which were used as scrapers for bone-working and as incisors for wood-working. Six incisors also exhibited some evidence for use as drills. The backed edge of LC#48 was used for scraping bone, while the chisel-like tip was used to incise both wood and bone. The chord of LC#49 was used for cutting and scraping a resinous, charred wood, and the tip may also have been used for incising wood and bone.

Mineral residues including ochre, vivianite and aragonite were also visible on a number of bone-working artefacts. Twenty-eight artefacts had ochre residues, mostly red ochre although occasionally (n = 9) both red and yellow ochre. Twenty artefacts had vivianite occurring in association with bone collagen residues, and of these, 18 had co-occurring ochre residues. Aragonite fragments were present on two artefacts (LC#23, LC#27), one of which (LC#27) also had ochre residues, but it was not possible to determine whether the source of the aragonite was land snail or fresh water mussel shell. On LC#27, the aragonite appeared to be mixed with resin. Hafting resin was identified on 19 of the 34 bone-working artefacts, while for the remainder there was insufficient evidence to make an inference.

Wood-working. Wood-working was another significant task inferred for the Lapstone Creek artefacts based on the observation of woody plant tissue and fibres, amorphous cellulose, plant exudate, charcoal and/or resin in various combinations and quantities (Table 2). Thirty-three artefacts were used for wood-working, generally on charred (n = 10) or resinous (n = 9) materials (Figs 8 and 9). Another three artefacts (LC#17, LC#21, LC#22) had slight evidence of having been used for wood-working based primarily on use-wear features. Twenty-five of the 33 artefacts had also been used for bone-working. Two artefacts (LC#11, LC#18) had been used for both wood-working and processing starchy plant material such as tubers or rhizomes. As discussed above in the section on bone-working, different edges may have been used for separate tasks, although in some instances the same edge was used on different materials. Based on use-wear and the distribution of residues, one of the principal inferred functions of the artefacts was scraping and/or adzing (n = 20), with four (LC#4, LC#5, LC#34, LC#36) also used for smoothing or "burnishing" the wood. The scrapers included all the wood-working elouera (n = 13) as well as seven Bondi points. For the latter, the backed edge and/or the obtuse angle ridge appeared to have been used for scraping. The second major function was incising, drilling or piercing (n = 19), which involved only the "points". Their tips were generally worn smooth and the backing often continued right to the tip giving these artefacts increased strength (Fig. 10). In seven cases (LC#21, LC#22, LC#36, LC#44, LC#48, LC#49, LC#50), the artefacts were multi-functional with the backed edge and/or obtuse angle ridge employed for scraping and the tip used for incising, drilling and/or piercing. For LC#23 and LC#42, although both wood and bone-working residues were present, no specific function was allocated as the tips were snapped and subsequent edge damage may not have fully reflected the method of use. LC#48 may have been used as an incisor on both wood and bone. Twenty-two artefacts had ochre residues.

General plant processing. Nine artefacts were used for processing non-woody plant material (Table 2). The principal residues associated with this task consisted of plant tissue, amorphous cellulose, starch grains, fibres, plant sap or exudate and occasionally phytoliths, raphides and resin. Of the nine, two (LC#11, LC#18) were employed to process starchy plants such as roots, rhizomes or tubers. For LC#18, the starch appeared gelatinized indicating that it had been cooked or at least heated. A further four artefacts (LC#22, LC#24, LC#29, LC#30) had some evidence for use on plants, but this was insufficient for inferring a specific task. Seven of the nine artefacts were multi-functional, having been used for both plant processing and bone-working. Inferred functions were scraping bark from woody stems and cutting or shredding soft fleshy and occasionally resinous plants.



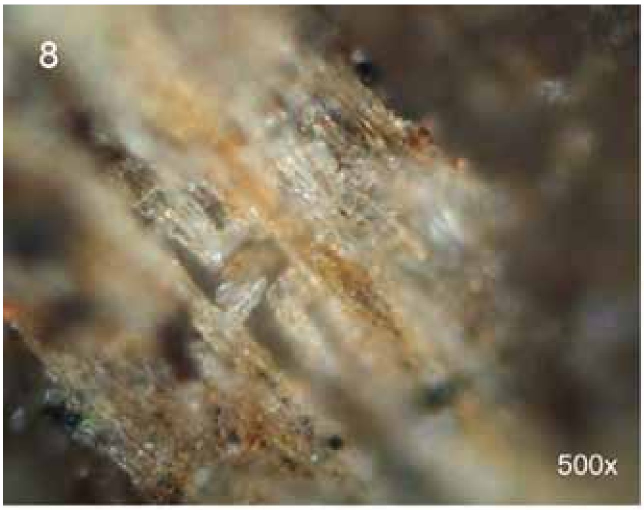
Figures 5–7. *(5)* A large fragment of bone in a flake scar on the dorsal surface of LC#7 (brightfield illumination, cross-polarized). *(6)* Bone collagen with vivianite scraped onto the backed edge of LC#7 (darkfield illumination). Inset: Bone collagen at 500× (brightfield illumination, cross-polarized). *(7)* Massive edge scarring, mostly multiple step flake scars, all along the chord of LC#18 (Wild).

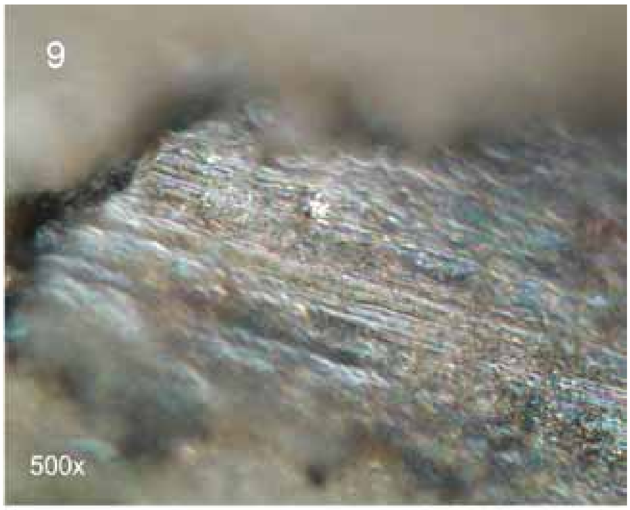
Ochre residues. Ochre residues in various quantities were observed on 40 artefacts (Table 2 and Fig. 11). On 28 of these, the ochre was red while 11 artefacts exhibited both red and yellow ochre. One artefact (LC#28), which was used for incising wood, had only yellow ochre. Ochre occurred in scattered fragments or smeared clumps scraped onto edges or ridges, and was generally found in association with other residues such as bone collagen or resin. On LC#25, red and yellow ochre were the only notable residues despite the presence of some use-wear features, so that the task association and function of this artefact remained uncertain, although a possible decorative or ritual purpose is proposed. No soil samples were available for analysis, and the possibility that the ochre on some artefacts was soil derived could not be entirely excluded, although, given the quantities and distribution on the tool, it is unlikely.

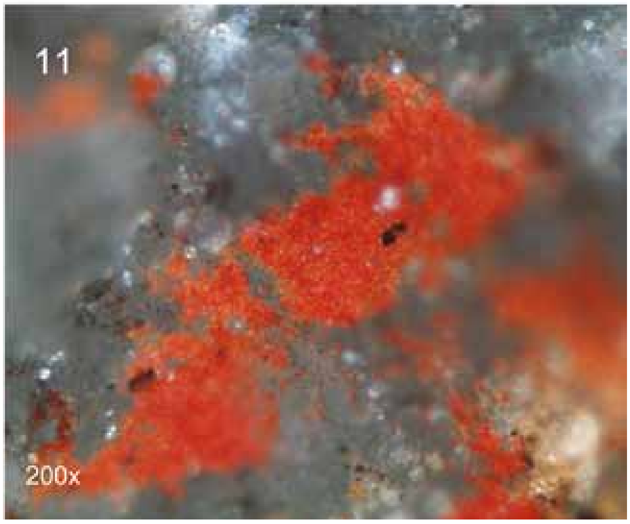
Hair. Hair fragments occurred on three artefacts (LC#5, LC#6, LC#45). None of the fragments were in adequate condition for further identification because the hair surfaces were so degraded that only a few scales were visible. On LC#5, several black degraded hairs were scraped onto a lateral margin that had been used for bone-working and probably related to the task of scraping bone at the secondary stage. A black degraded hair on a ridge just back from a working edge on LC#6 was probably also associated with bone-working. For LC#45, a Bondi point with an inferred function of incising both bone and wood, degraded fine hair fragments on the backed edge at the proximal end (and without associated use-wear) may relate to the hafting process, as there is ethnographic evidence that hair was used as a temper in resin (Ross, 1976). Putative blood residue and bone fragments were also observed on the proximal end of this artefact and, alternatively, the hair fragments may have been associated with hafting of the artefact in bone.

Blood residues and summary of Hemastix™ test results. Because of the destructive nature of the sampling procedure, very small artefacts were excluded if no animal residues were observed during optical microscopy. Thus, the test was not performed at all for 14 artefacts, and on two artefacts the test was performed at one site only (usually two sites sampled). Four artefacts (LC#23, LC#27. LC#35, LC#37) produced positive reactions to the Hemastix™ Test. Blood residues were not observed on these artefacts during microscopic examination, although all had been used for bone-working. Positive results were probably due to the presence of myoglobin and/or undetected blood film.

Two artefacts (LC#32, LC#45) had visible blood residues when examined microscopically. Red blood cells in smeared residue on LC#32 averaged 4–5 µm in diameter and were non-nucleated and roughly circular in shape indicating that they were mammalian. However, although an initial positive "trace" was recorded for the Hemastix™ Test, the addition of NaEDTA to the sample produced a negative result. Dilution of the small sample with NaEDTA solution may have reduced haemoglobin/myoglobin concentration below the threshold for a reaction. On LC#45, an artefact with an inferred use of both bone- and wood-working, a thin film of blood residue with red blood cells approximately 5µm in diameter was observed on the proximal end. Also present on this artefact were several degraded hair fragments and bone







Figures 8–11. *(8)* Smeared woody tissue on an obtuse angle ridge on the dorsal surface of LC#4 (brightfield illumination, cross-polarized). *(9)* Striations sub-parallel to the chord across an obtuse angle ridge on the dorsal surface of LC#15 in thick charred resin (darkfield illumination). *(10)* Pronounced rounding on the distal tip and both margins, and faint parallel striations running back from the tip on LC#19 (Wild). *(11)* Red ochre smeared and scraped onto the backed edge of LC#7 (brightfield illumination, cross-polarized).

fragments with associated vivianite. The Hemastix™ Test on this artefact was negative possibly because there were too few red blood cells present in the sample.

Resin and hafting assessment. Twenty-eight artefacts exhibited some evidence for hafting based on resin distribution and relative quantity (Table 2, Figs 12, 13). Of these, 15 were used for both bone- and wood-working and one for both bone-working and non-woody plant processing. Three hafted artefacts were used to work bone only, five to work wood only and one only for plant processing. The remainder of the artefacts had insufficient evidence to make an inference. In addition, much of the resin on the Lapstone Creek rock-shelter artefacts appeared to have been burnt or charred (Fig. 14).

For the hafted artefacts, 11 may have had a bone haft based on the type and distribution of bone collagen away from worked edges and/or in association with the hafting resin (Fig. 15). Mitchell (1949: 56) provides the only available published reference on the conjectured use of a bone haft. He described hafting of geometric microliths into "a cleft on the end of a short stick or bone" using "vegetable cement." Although there is limited ethnographic and archaeological evidence for the use of bone to haft stone implements in Australia, and in particular, microliths, this practice has been employed in other parts of the world for millennia (Bárta, 1985; Oshibkina, 1985; Zagorska & Zagorskis, 1985; Lombard, 2008). Another possible source of bone residues on the backed edge or proximal end of the artefacts is the use of a bone implement as an indentor for backing (Kim Akerman, personal communication, 2004) or, alternatively, the scattered bone residues could be due to indiscriminate transfer during use.

Discussion

The inferred task associations based on the observed residues and use-wear patterns for the 50 artefacts from Lapstone Creek rock-shelter included bone-working, wood-working, general or non-woody plant processing (including processing of starchy plants) and, in one case, use in a possible ritual or ceremonial context. These results are not dissimilar to those from other sites in the Sydney basin such as Emu Tracks 2 and Deep Creek, where backed artefacts excavated by Attenbrow (1981, 1987) have also been subjected to a residue and use-wear analysis (Robertson, 2002, 2005; Robertson & Attenbrow, 2008; Robertson *et al.*, 2009). However, at Deep Creek, evidence of possible use for hunting was observed (Robertson, 2005) and most of the backed artefacts found in association with a skeleton excavated at Narrabeen,

Figures 12–15. *(12)* A semi-circle of resin on the backed edge at midway on the ventral face of LC#21 (Wild). *(13)* Brown, glassy resin near the backed edge on the proximal end of LC#32 (darkfield illumination). *(14)* Mud-cracked, charred resin towards the backed edge on the ventral face of LC#21 (brightfield illumination, cross-polarized). *(15)* Bone collagen and smeared charred resin on proximal end of LC#41 (brightfield illumination, plane-polarized).

a northern Sydney suburb, and analysed by Fullagar (McDonald *et al.*, 2007; Fullagar *et al.*, 2009) had impact damage, interpreted as the result of spearing. One backed artefact found with the Narrabeen skeleton bore traces of skin working (Fullagar *et al.*, 2009: 880; cf. McDonald *et al.*, 2007), an activity also inferred for a number of artefacts from Emu Tracks 2 (Robertson, 2005; Robertson & Attenbrow, 2008). At Lapstone Creek however, there was no evidence to support the use of backed artefacts for either skin-working or hunting/butchering. Bone-working and wood-working were the most significant tasks, although most of the artefacts were multi-functional, often with different edges used for different tasks, but occasionally the same edge applied to different materials.

Bone-working. The use of bone as tools and ornaments by Aboriginal Australians is frequently mentioned in the ethnographic literature, although there are few references concerning the use of flaked stone to produce or modify the bone artefacts (Attenbrow, 2002: 109; Fullagar, 1994: 218; Kamminga, 1982: 47). In her comprehensive review of the archaeological and historical literature relating to the Sydney area, Attenbrow (2002: 117) summarized the use of kangaroo and wallaby bone for the production of tools and weapons in the historic period. She also refers to archaeological evidence for the use of bone implements during the last 3000 years, both in the presence of the tools themselves and in manufacturing debris (Attenbrow, 2002: 117). According to Kamminga (1982: 47), bone points produced from either mammalian or bird bone are the most widespread bone artefact, and grinding is the preferred method of shaping. Bone points have been excavated from Pleistocene sites, with those from Devil's Lair, dated to 29,000 BP, the oldest so far recovered (Francis, 2002: 63). Attenbrow (2002: 109) notes that nose pegs made from kangaroo leg bones sharpened to a point at one end, were commonly worn by Aboriginal men. Brayshaw (1986: 67), in her review of the Colonial records for the Hunter region, describes the use of awls made of kangaroo bone to repair canoes and sew skins. Bone points used as ritual objects in northwest Queensland were commonly made from a human forearm or emu bone, ground to a point at one end and with human hair or possum fur string attached to the other (Roth, 1897, cited in Morwood, 1979: 66).

The use of flaked stone for modifying bone is mentioned only infrequently in the ethnographic literature. Flaked stone knives were employed for scraping and/or cutting bird and mammal bones in the preparation of spatulas and yam knives in northern Australia (Tindale, 1928, cited in Kamminga, 1982: 49). Kamminga (1982: 51) also refers to the reported use of a stone drill to perforate dingo teeth to produce a necklace, although there is no reference to the drilling of bone. Necklaces of dingo and kangaroo teeth were also worn in the Sydney region (Attenbrow, 2002: 108, fig.

9.1). In light of the paucity of ethnographic evidence for the working of bone with flaked stone, the identification of bone-working activities at Lapstone Creek rock-shelter is a particularly interesting finding.

Wood-working. On the other hand, the use of backed artefacts for wood-working was not entirely unexpected as there were a number of eloueras in the sample. When hypothesizing about the use of backed artefacts in Australia, archaeologists have generally made a distinction between Bondi points, geometric microliths and eloueras. On the basis of use-wear features, several archaeologists have proposed that eloueras were used as hafted adzes or scrapers for working wood (Lampert, 1971; Kamminga, 1977; Moore, 2000). Others propose a domestic use, with backed artefacts hafted in composite tools such as knives or "cutting implements" (Stockton, 1970; Flood, 1980; Dickson, 1981; Morwood, 1981; Fullagar, 1992, 1994; Boot, 1993; Moore, 2000). There is one available reference to the possible use of Bondi points as incisors for wood-working. A hafted stone-engraving tool from western Queensland is described as being used to score "grooves on wooden implements and in ornamenting shields and boomerangs" (Tindale, 1945: 83). The stone is microlithic in size and is hafted in resin onto a wooden handle. Tindale (1945: 83) suggests that its "form, method of manufacture and mounting shed light on the function, or one of the functions, of [backed artefacts]."

The manufacture and maintenance of wooden implements and objects are major features of ethnographic and ethnohistoric reports of traditional Aboriginal activities. Flood (1995: 146), considers stone tools were used primarily to make other tools, and comprised only a small proportion of the traditional Aboriginal tool kit. In fact, Flood (1995: 146) considers the majority of Aboriginal equipment consisted of "wood, bone, shell or plant material." According to Kamminga (1982: 56), most flaked stone tools are used for wood-working activities. Ethnographic reports contain numerous descriptions of wooden items used by Aboriginal people, including spears, spear-throwers, shields, digging sticks, clubs, bowls and boomerangs (Attenbrow, 2002: 112). Wooden nose pegs and needles were also observed in use (Attenbrow, 2002: 113). Some boomerangs (purportedly from the Sydney region) in museum collections have incised decorative markings (Attenbrow, 2002: 96), as do shields from the Hunter region (Brayshaw, 1986: 64). There are few references, however, to the method of manufacture of these wooden items. Along the Hawkesbury-Nepean River, stone hafted into the end of a spear-thrower was used to make spears (Attenbrow, 2002: 89). Tindale's (1945: 83) description of a microlithic hafted stone engraver in the Queensland Museum also provides ethnographic evidence for the use of stone artefacts for wood-working.

Although no pre-contact wooden implements have been excavated in the Sydney region, residue and use-wear studies of stone artefacts from several sites confirm the use of stone in the manufacture of wooden artefacts (Attenbrow, 2002: 113). In addition, 10,000-year-old wooden implements including spears, boomerangs and digging sticks, have been found in association with stone tools at Wyrie Swamp, South Australia (Flood, 1995: 146–147). Organic residues on the stone tools indicate they were used for wood and plant food processing. Although the tools in question are core tools and scrapers, this Early Holocene archaeological evidence demonstrates the longevity of working wood with stone tools. This activity has been clearly demonstrated for backed artefacts at Lapstone Creek, where various edges were used for scraping with occasional smoothing or burnishing, cutting or slicing, and, specifically for the asymmetric artefacts or "points," incising and/or drilling and/or piercing. Here, it is the inferred function of the asymmetric artefacts rather than the eloueras, which was a surprising result.

General plant-processing. Although not a major activity in Lapstone Creek rock-shelter, some backed artefacts were used for general plant processing. The concept of backed artefacts as domestic cutting implements is one of the proposals offered by Stockton (1970: 228) based on the presence of large numbers of unbroken Bondi points in occupation sites. He makes a comparison with projectile points, which, when found in living areas in other countries such as the Middle East, are usually broken. He observed use-wear on the chords of recovered artefacts, and interpreted this as evidence for their use as knives. Although not necessarily in a domestic situation, employment as a composite cutting tool has also been suggested (Flood, 1980: 318; Dickson, 1981: 65; Morwood, 1981: 20). This proposition however, relates more to function than to a task associated with plant processing. In fact, an association with plant processing and a function as a cutting tool have only been proposed as a use for backed artefacts in the last decade since the advent of use-wear and residue studies (Fullagar, 1992; Boot, 1993; Moore, 2000). Fullagar (1992: 10), in particular, suggests that backed artefacts are elements in "composite hafted tools, used for cutting both animal and plant tissue."

Although flaked stone comprises a large proportion of all excavated archaeological material, there are no clear descriptions of the use of flaked stone for plant processing in the ethnographic and ethnohistoric records for the Sydney region (Attenbrow, 2002: 100–101). Stone implements were used in the production of cord or string from bark, and in the processing of vegetable foods such as fern-root (*Blechnum indicum*), yams (*Dioscorea* spp.) and other tubers (Attenbrow, 2002: 91). The use of bark from different tree species for a number of purposes, including as fishing lines, net bags, cloaks and baskets, is documented, as is the use of the stem, fronds and resin of the grass tree (*Xanthorrhoea* sp.) (Attenbrow, 2002: 113, 116). Procurement of these would necessitate the use of a sharp implement, possibly flaked stone or shell, although there is no documented evidence for these. The backed artefacts from Lapstone Creek rock-shelter have been employed as scrapers and/or knives for at least some of these activities.

Blood, ochre and other residues. Significantly, there were few blood residues, with only four artefacts producing positive reactions to the Hemastix™ Test and a further two having visible blood residues. Blood residues appear to relate to use of the artefacts for bone-working or their having been hafted in bone rather than uses in butchery or hunting because the quantities of blood are so small and the associated residues largely consist of bone collagen in various forms, collagen fibrils, resin and ochre. Ochre was a significant residue, occurring on 40 artefacts, and was usually associated with bone or wood-working residues. Hair occurred on only three artefacts and was so poorly preserved that no further identification was possible. Five artefacts had fragments of aragonite, but these did not appear to relate to use and their presence was probably due to incidental transfer from the surrounding soil. More than half the artefacts exhibited evidence for hafting at some stage in their use life.

Conclusions

This study has resulted in a number of significant discoveries regarding the use of backed artefacts in Australia. There is no ethnographic analogy and until recently, no clear archaeological evidence for the use of backed artefacts in the Australian context. The recent recovery of the Narrabeen skeleton with backed artefacts in situ confirms one of their uses as composite elements in hafted knives, spears or clubs (McDonald *et al*., 2007; Fullagar *et al*., 2009). However, the results of the analysis of backed artefacts from Lapstone Creek indicate a much greater emphasis on craft and maintenance activities.

The use of backed artefacts as bone-working tools was particularly significant, as no previous researchers have predicted their use in this activity. There was considerable overlap of functions owing to the multifunctional character of many artefacts, but most bone-working tools were used primarily as incisors and scrapers. Well over half the bone-working artefacts have hafting evidence, and Bondi points were more likely to have been hafted than other types. The use of backed artefacts for wood-working was not entirely unexpected as wooden artefacts have been recorded both ethnographically and archaeologically, and there is evidence for the use of stone artefacts in their production, decoration and maintenance. The use of eloueras as scrapers/adzes has been both hypothesized and confirmed by previous use-wear studies and again here. At Lapstone Creek rock-shelter, however, Bondi points also functioned as scrapers and knives for wood-working. In addition, the study shows that incising/engraving tools were a key activity for many Bondi points. There is ethnographic evidence for incising wood, but little archaeological evidence in the form of incised wooden artefacts, making this a significant finding. The use of backed artefacts as elements in hafted composite knives for domestic use has also been proposed, although there are few references to their specific use on plants and ethnographic evidence for the use of flaked stone in plant processing is sparse. However, some backed artefacts from Lapstone Creek rock-shelter were used for food extraction and processing.

The majority of backed artefacts at Lapstone Creek rock-shelter were employed in craft activities, including specialized tasks involving decoration and possibly maintenance of wooden and bone implements. The fact that Australian backed artefacts are multi-functional concurs with similar findings about "microliths" in other parts of the world (e.g., Wadley & Binneman, 1995; Milisauskus, 2002). This research has tested previous hypotheses concerning backed artefact use by identifying many of their task associations and functions, and it has also provided significant additional information regarding Aboriginal economic and social activity in the Sydney region during the late Holocene, the period during which backed artefacts were produced in great abundance. Knowledge of the range of activities for which backed artefacts were used during this period provides insight into the context of observed changes in the Australian archaeological sequence and gives some indication of the strategies adopted by Aboriginal foragers during a time of climatic and environmental change.

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